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APPLICATION FOR LETTERS PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

TITLE: Bariatric Bed Apparatus and Methods

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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION.

The present invention relates to bariatric beds and, more particularly, to bariatric beds of the type convertible to a reclining bariatric chair and having features for facilitating the comfort, care and support of the bariatric patient.

2. BACKGROUND.

The care of morbidly obese patients, also known as bariatric patients, presents many extraordinary challenges which have not been adequately addressed in the past. Not the least of the challenges is basic physical handling of such patients. Even partially lifting a bariatric patient often requires three or four very strong nurses. Supporting their huge size and weight on a bed likewise requires the bed to have tremendous structural strength and stability. An eight hundred pound patient will not only render many of the controls of a typical hospital bed inoperative, but will literally crush components just by sitting on the bed. Structural instability, moreover, tends to increase with complexity. Consequently, although standard hospital bed frames like the Hill-Rom 835 frame can be full-featured, caregivers of bariatric patients have long had to rely on bariatric beds with very basic support structures and limited features.

Examples of known bariatric beds include the "Magnum" bed previously manufactured by Mediscus Products, Ltd. of Wareham, England and the "Burke" bed manufactured by Burke, Inc. of Mission, Kansas.



SUMMARY OF THE INVENTION

It is a fundamental object of the present inventions to improve over the prior art, including to provide a bariatric bed and related methods which facilitate the care, comfort and support of bariatric patients. A related object is to provide a bariatric bed with features comparable to those of a conventional hospital bed while also providing features uniquely adapted for the care, comfort and support of bariatric patients.

These and other objects are addressed, in part, by providing a full-featured bariatric bed. One basic aspect of the invention is to provide such a full-featured bariatric bed wherein the frame includes a raise-and-lower mechanism together with controls for tilting the patient surface lengthwise, hence providing Trendelenburg and/or reverse Trendelenburg capabilities. Structure is also provided for articulating the patient surface from a relatively horizontal, lying position to a seated position. The raise-and-lower mechanism may include two separately actuated jacks of sturdy placement and construction, one for lifting the foot end of the bed's seat section and the other for lifting the head end of the bed's seat section. Such construction permits general raising or lowering of the entire patient surface by operating the jack motors synchronously in the same direction, and permits longitudinal tilting by operating the jack motors at different speeds or in opposite directions.

Another aspect of the present invention is the provision of opposite siderails that are both adjustable and retractable. The siderails are adjustable in the sense that they can be raised and locked in their operative position at a lateral distance (i.e., distance from the primary seat cushion) that is adjustable. They can be raised in a normal, inner position, or they can be adjusted to an extended position for particularly wide patients. They can even be adjusted further inward than their normal position without being removed from the bed, to a transport position for facilitating transport of the bed through standard hospital doorways. The siderails are retractable not only in the sense that they can be retracted to the transport position, but also in the sense that they can be easily

lowered without removing them from the bed. To further enhance the user-friendliness of the bed, the invention also provides for the provision of identical bed controls built in to each of the opposite siderails. Thus all functions can be controlled from a convenient control panel. Such controls are integrated into the siderails without risking injury to the siderail data lines by directing those lines through a tunnel in the siderail mounting arms. Pendant controls may also be included for even greater ease of use.

Yet another aspect of the present invention is the provision of a bariatric bed including a balanced X-ray cassette holder for enabling use of a radioluscent head section thereof. The entire central span of the head (and chest) section may be radioluscent, and the balanced X-ray cassette holder allows adjustment of X-ray film position thereunder.

The present invention also provides a bariatric bed having a footboard which is adapted for use as a step to enable ingress and egress relative the bed. Such a footboard may be pivotally connected to the leg section of the bariatric bed so that it can pivot into close engagement with the floor when stepped on. Damping cylinders and springs may be used to optimally restrict such pivoting in use, and upper and lower cushions, ideally of different properties, may be employed for further benefits.

Although some details are summarized above, this summary generally only begins to touch on the broader technological categories to which the present inventions are directed. Many other objects, features and advantages of the present inventions will be evident to those of skill in the art in view of the foregoing and following more detailed descriptions, particularly when considered in light of the prior art and/or the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a bariatric patient treatment bed 29 comprising the presently preferred embodiment of the invention described herein.

FIG. 2 is an exploded perspective view of the bariatric patient treatment bed 29 of FIG. 1.

FIG. 3 is an exploded perspective view of the base frame 61 and plastic base frame covers 46-48 and 250 for the bed 29 of FIG. 1 shown with some parts removed for clarity.

FIG. 4 is an exploded perspective view of the base frame 61, load frame 62 and scale mechanism of the bed of FIG. 1 shown with some parts removed for clarity.

FIG. 4A is an enlarged scale sectional view showing the flexure elements of the scale mechanism which dependently attach the load frame 62 to the base frame 61.

FIG. 5 is an exploded perspective view the load frame of the bed of FIG. 1.

FIG. 6 is an exploded perspective view of the seat assembly of the bed of FIG. 1.

FIG. 7 is an exploded perspective view of the head and X-ray assembly of the bed of FIG. 1.

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FIG. 8 is an exploded perspective view of the left hand side rail assembly of the bed of FIG. 1.

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FIG. 9 is an exploded perspective view of the leg and foot assemblies of the bed of FIG. 1.

FIG. 10 is an exploded perspective view of the hand held control pendant for the bed shown in FIG. 1.

FIG. 11 is a schematic view of the power distribution and control system for the bed of FIG. 1.

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FIG. 12 is a flow chart showing serial communication for the control system of FIG. 11.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, there is shown a treatment bed 29 uniquely indicated for bariatric patients, i.e., patients weighing in excess of 500 pounds, commonly in the range of 500-800 pounds.

The bed 29 shown is considered to be the presently preferred embodiment of the inventions described and claimed herein. The frame 10 of bed 29 (with particular reference to FIG. 2) generally comprises base frame 61, load frame 62 and assemblies 51, 52, 53 and 54. The basic mattress 11 (or "patient surfaces"), of bed 29 consists of Cushion assemblies 31-33, although overlay surfaces may also be implemented on top of the basic mattress 11 controls for the bed 29 are contained in the frame 10, including in its side rails 40-41 and its pendant. Frame assemblies 51-54 and corresponding cushion assemblies provide support for the patient's head, buttocks, legs and feet, respectively. Head and X-ray assembly 51 (also referred to as "X-ray assembly 51") further comprises a mechanism for holding an X-ray cassette as shown by FIG. 7 and detailed further herein. Seat assembly 52 further comprises jack motors 114 and 116 as shown in FIG. 6. Jack motors 114 and 116 are used to adjust the angular orientation relative to seat assembly 52 of head and X-ray assembly 51 and leg assembly 53, respectively, as will be evident further herein. Foot board assembly 54 is dependently attached to leg assembly 53 by connections providing useful benefit to both the patient and care giver as shown in FIG. 9 and detailed further herein. Cushion assemblies 30, 31, 32 and 33 rest upon head assembly 51, seat assembly 52, leg assembly 53, and foot board assembly 54, respectively. Cushion assemblies 30-33 engage the patient to provide comfortable support thereof.

As best shown in FIG. 3, base frame 61 generally comprises longitudinal beams 65 and 66 and transverse elements 63 and 64. Base frame 61 further comprises a plurality of floor engaging casters 34, 35, 36, and 248 conventionally journaled near the four corners of said frame. Locking mechanisms 37, 38 and 39 and a fourth of the same kind (not shown) are provided for casters 34,

35, 36, and 248, respectively. Such locking mechanisms may be set to prevent either rotation or steering of the casters 34-36 and 248, hence holding bed 29 stationary, as is conventional with many hospital bed frames. Weldments 68-71 are provided which allow location of corner posts 42-44 and 249 on which may be installed intravenous injection (IV) holders or standard traction frames. Corner posts 42-44 and 249 are adapted with convenient integral hand holds 42'-44' and 249' to facilitate patient entrance or exit of bed 29. The hand holds 42'-44' and 249' provided by corner posts 42-44 and 249 may also assist caregivers in transport of bed 29. Molded plastic covers 46-48 and 250 enhance aesthetic appeal and provide convenient locations for affixing instruction or warning labels. Bumpers made of rubber or other similar materials may also be installed on covers 47 and 48 for protection of both bed 29 and the walls and doorways of the facility where the bed is used.

As best shown in FIG. 4, load frame 62 generally comprises longitudinally disposed beams 72 and 73 and transverse elements 74 and 75. Additional transverse elements 76 and 77 are used for attachment of jack motors 90 and 92, respectively. The description and function of motors 90 and 92 will be apparent further herein. Load frame 62 is referred to as such because it carries the entire load of the patient surface 11. Load frame 62 dependently attaches to base frame 61 in a way that weighs that load as it is transmitted to base frame 61. That connection between bed frame 62 and base frame 61 is provided by a scale mechanism is well known in the art and similar to that described in U.S. Pat. No. 4,793,428, incorporated herein by this reference. The scale mechanism comprises a pair of displacement transmitting members 84 and 85 which are respectively connected between transverse elements 63 and 74 and 64 and 75 via flexures 78-81 and 243-246.

Referring to detail FIG. 4A, transmitting member 84 is shown as attached to base frame element 63 via flexure 246 and load frame element 74 via flexure 81. Attachment in this manner causes displacement of bars 82 and 83 which are connected to members 84 and 85 in cantilevered manner. Displacement, which is limited by springs 86 and 87, is measured in the area

of springs **86** and **87** by linear variable differential transformers (LVDTs) **88** and **89**. Displacement measured by LVDTs **88** and **89** corresponds in direct proportion to the weight of the load frame and all which is supported thereby. Locking mechanism **67** comprising common hardware is desired to prevent motion of load frame **62** relative to base frame **61** during transport of bed **29**. This serves to prevent damage of the scale mechanism due to excessive forces as may be encountered when attempting to negotiate a short step or the like. Other conventional mechanical stops are also used to limit movement and prevent damage in normal use, when locking mechanism **67** is not in use.

Referring to FIGS. **5** and **6**, raise-and-lower mechanism for producing vertical movement Trendelenburg tilting of the seat assembly **52** is shown in detail. In particular, head torque arm weldment **106** and foot torque arm weldment **110** are pivotally attached to load frame **62**. Seat assembly **52** is dependently attached to weldments **106** and **110** by members **102**, **105**, **108** and **109**. Specifically, foot torque arm weldment **110** connects at points **101** and **107** to members **108** and **109** by bushings and other necessary hardware as is well known in the art of manufacturing hospital beds. Head torque arm **106** and foot torque arm **110** weldments are articulated about their pivotal attachments to load frame **62** (numbered **106'**, **106''** and **110'**, **110''**, respectively) by extension or retraction of jack tubes (or "sleeves") **91** and **93** by jack motors **90** and **92**, respectively. Jack motors **90** and **92**, of the type referred to in the industry as linear actuators, attach transverse members **76** and **77** of load frame **62** by torque arm pins **95** and **97** themselves affixed by cotter pins **96** and **98**.

Extension of tube **93** by motor **92** causes weldment **110** to pivot relative to load frame **62** such that points **101**, **107** and corresponding members **108**, **109** articulate upwardly. Likewise, extension of tube **91** by motor **90** causes weldment **106** to pivot such that members **102** and **105** articulate upwardly. Retraction of tubes **93** or **91** would have the opposite effect, that of lowering members **108**, **109**, or **102**, **105**. Said articulation has the effect of causing members **102**, **105**, **108**

and 109 to raise or lower in vertical motion, thereby raising or lowering seat assembly 52 in vertical motion. In the preferred embodiment, such articulation as raises seat assembly 52 is said to provide a BED UP function. Such articulation as lowers seat assembly 52 is said to provide a BED DOWN function. It is believed that the system described herein having mechanically articulated attachment points at the four corners of seat assembly 52 promotes greater stability than would a system utilizing hydraulic type cylinders wherein the support is typically concentrated along a single longitudinal axis.

Articulation by one jack motor 90 or 92 greater or less than that of the other jack motor 92 or 90 has the effect of establishing the patient support surface in a Trendelenburg or reverse Trendelenburg treatment position. Trendelenburg and reverse Trendelenburg therapy is well known in the art for treatment of certain cardiac conditions and is considered an important feature for many conventional hospital beds, although the excessive weight of bariatric patients has led the art away from incorporating such features in a bariatric bed. The preferred embodiment is capable of achieving ten degrees Trendelenburg or twelve and one half degrees reverse Trendelenburg therapy. Articulation to effect such treatment is referred to as providing the TRENDELENBURG or REVERSE TRENDELENBURG function.

Referring now to FIG. 5 only, load frame 62 is shown to be a convenient location for mounting of transformer assembly 103 and junction box assembly 104. The functions of each of these assemblies will be detailed further herein. Additionally, inductor-capacitor-resistor (LRC) networks 99 and 100 are conveniently mounted on load frame 62 so as to conserve space within junction box assembly 104. LRC networks assemblies 99 and 100 are primarily indicated for the capacitive startup of jack motors 90 and 92 and protection of the power distribution and control system from back electromotive forces (EMF) generated by said initial startup of either jack motor 90 or 92.

Referring to FIGS. 6 and 7, it is shown that head assembly 51 is dependently attached to seat assembly 52 by laterally oriented hinge 131. Articulation of head and X-ray assembly 51 about hinge 131 is effected by extension or retraction of jack sleeve 117 under the force of jack motor 116. Jack motor 116, of the type referred to in the industry as a linear actuator, dependently attaches to seat assembly weldment 112 by pin 120, itself affixed by cotter pin 121. Jack sleeve 117 attaches to head and X-ray assembly weldment 132 by pin 118, itself affixed by cotter pin 119. In the preferred embodiment, extension of jack sleeve 117 is said to provide a HEAD UP function. Retraction of jack sleeve 117 is said to provide a HEAD DOWN function. Head and X-ray assembly 51 is detailed further herein.

Referring now to FIG. 7, the head assembly 51 for treatment bed 29 is shown. Head assembly 51 generally comprises rail 140 encompassing head board 141 which together are mated with weldments 128, 129 and 130. Weldments 128 and 129 produce a channel for horizontal containment of an X-ray cassette. Transverse weldment 130 combines with hinge 131 and weldment 132 to provide structural support of head and X-ray assembly 51. X-ray board 139 serves to maintain the right angled shape of the perimetrical structure thereby aiding in ensuring ease of insertion and removal of an X-ray cassette. X-ray board 139 and head board 141 comprise a radioluscent material in the preferred embodiment. While it is well known in the art of design and manufacture of patient treatment beds to provide a mechanism for holding an X-ray cassette behind the patients head and chest areas, prior art designs have not improved the means for insertion and removal of the X-ray cassette. Specifically it is desirable to be able to raise or lower the cassette from one side only so that in cases where access to the treatment bed may be limited to one side, by a wall or medical apparatus, for instance, an X-ray cassette still may be easily inserted and subsequently removed. Because prior art embodiments of bariatric beds do not provide mechanisms for keeping the sides of an X-ray cassette parallel with the sides of holding assembly, the caregiver

has been forced to have access to both sides of the treatment bed in order to manually guide the cassette into place. The embodiment detailed herein utilizes a mechanism from other arts to provide a solution to the problem described. A block and pulley system comprising a left block and right block 134, plurality of single pulleys 136 and 138, plurality of double pulleys 137 and plurality of cables 135 allows X-ray bar 133 to be raised and lowered from one only of a plurality of handles 142 all the while maintaining position parallel to transverse element 130. The handles 142 may lock at a plurality of vertical positions within slots 143 in channel members 128 and 129. Although referring to an un-related field of art, the block and pulley system shown is similar to that described in U.S. Pat. No. 5,295,430, incorporated herein by this reference.

Referring now to FIGS. 6 and 9, it is shown that leg assembly 53 is dependently attached to seat assembly 52 by laterally oriented hinge 113. Articulation of leg assembly 53 about hinge 113 is effected by extension or retraction of jack sleeve 115 under the force of jack motor 114. Jack motor 114, of the type referred to in the industry as a linear actuator, dependently attaches to seat assembly weldment 112 by pin 122, itself affixed by cotter pin 123. Jack sleeve 115 attaches to leg assembly weldment 194 by pin 124, itself affixed by cotter pin 125. In the preferred embodiment, extension of jack sleeve 115 is said to provide a LEGS UP function. Retraction of jack sleeve 115 is said to provide a LEGS DOWN function. Leg assembly 53 is detailed with foot board assembly 54 further herein.

In the preferred embodiment, full extension of jack sleeve 117 in order to provide full HEAD UP and simultaneous full retraction of jack sleeve 115 in order to provide full LEGS DOWN causes conversion of patient treatment bed 29 into a reclining chair. In combination with unique benefits provided by the leg and foot board assemblies 53 and 54, detailed further herein, the chair position of treatment bed 29 particularly facilitates entrance or exit of the bed by a bariatric patient. It should also be noted that seat assembly 52 provides convenient mounting for patient restraint system

weldments 126 and 127.

Referring to FIG. 9, there is best shown foot board assembly 54 as dependently attached to leg assembly 53, also shown. Leg assembly 53 generally comprises leg plate 161 as reinforced by "I" shaped weldment 194. Weldment 194 itself comprises a plurality of attachment points 169, 176 and 183, the purpose of which will be evident herein. Foot board assembly 54 generally comprises foot plate 162, a plurality of hinges 186 and 189, cushions 163 and 164 and heavy duty fabric cover 33. The cover 33 in the preferred embodiment, is "Dartex" P109" available from Penn-Nyla of Nottingham, England, as is the fabric covering for the whole of mattress 11.

As for the foam used in mattress 11, a wide variety may be suitable; however, with the exception of cushions 163 and 164, the foam used in the preferred embodiment is an antimicrobial open-cell polyurethane foam having a density of 1.8 pounds per cubic foot and 36 pounds compression. The foam used for cushion 163 in the preferred embodiment is similar but has a relatively large density of 2.7 pounds per cubic foot and 70 pounds compression. The foam used for cushion 164 in the preferred embodiment is also similar but is less dense than cushion 163, having a density of 2.0 pounds per cubic foot and 41 pounds compression. Both cushions 163 and 164 are wedge-shaped, with their greater thicknesses (roughly 1.75" and 0.5", respectively) being distal to hinge 189. The relative characteristics of these foam cushions serve their varied purposes.

It is well know in the art of design and manufacture of bariatric patient treatment beds to provide a means by which the patient can easily enter or exit the bed. Bariatric patients are often not able to hop or step down even short distances without injury or loss of balance. It is therefore to provide a means for entrance or exit which lifts the patient into the bed and similarly sets the patient's feet very near the floor when exiting the bed. In the prior art, it has been shown that a rigid foot board in combination with a chair position feature, as previously detailed herein, facilitates bariatric patient care. However, measures are taken to ensure such foot boards are not used as a step

when exiting the bed, presumably for safety reasons in view of the excessive weight of bariatric patients. The present invention goes against such teachings by providing a footboard 54 which is adapted to be used safely as a step for bariatric patients.

Referring still to FIG. 9, the attachment of foot board assembly 54 to leg assembly 53 is shown. Such attachment provides gradual increase in rigidity as weight is applied to foot cushion 35, so as to provide adequate support of the bariatric patient entering or exiting bed 29 yet avoiding fixed resistance to a sudden increase in force. It is shown that the primary attachment of foot board assembly 54 to leg assembly 53 is by hinge 186 through weldments 187 and 188 on the foot board assembly 53 and a plurality of holes 197 in weldment 194 of the leg assembly 53. Articulation about said hinge 186 is constrained by damping cylinders 172 and 179 and spring 165 as detailed further herein. Spring 165, in compression, attaches to leg assembly weldment 169 by pin 170 itself affixed by cotter pin 171. Spring 165 attaches to foot board assembly weldment 166 by pin 167, itself affixed by cotter pin 168. Hydraulic cylinder 179, of the type which dampens primarily in compression, attaches to leg assembly weldment 183 by pin 184 itself affixed by cotter pin 185. Hydraulic cylinder 179 attaches to foot board assembly weldment 180 by pin 181, itself affixed by cotter pin 182. Hydraulic cylinder 172, of the type which dampens primarily in tension, attaches to leg assembly weldment 176 by pin 177 itself affixed by cotter pin 178. Hydraulic cylinder 172 attaches to foot board assembly weldment 173 by pin 174, itself affixed by cotter pin 175. The particular cylinder 179 selected in the preferred embodiment is an adjustable cylinder having a two-inch stroke and available through Enidine of Orchard Park, New York, part number (LR)OEM 1.5M X 2. The particular cylinder 172 selected in the preferred embodiment is an adjustable cylinder having a four-inch stroke and available through Enidine of Orchard Park, New York, part number ADA 510T. The particular spring 165 selected in the preferred embodiment is a medium load round wire spring available through Lee Spring Company of Brooklyn, New York, part number LHL-1

500A-9MW.

Under the weight of a bariatric patient, hydraulic cylinder 179 increasingly resists articulation of foot board assembly 54 about hinge 186. Gradually, resistance will increase as more weight is applied by the patient. In this manner, foot board assembly 54 is able to provide increasingly rigid support of the bariatric patient while minimizing any risk of 54 snapping under the weight of a typical bariatric patient. Further if a bariatric patient should apply weight onto foot board 54 at excessive speed, the dampening action of hydraulic cylinder 179 may serve to prevent injury to the patients knees and legs. One weight is removed from foot board 54 (such as once patient has completely exited bed 29), spring 165 returns foot board assembly 54 to its original position with respect to leg assembly 53. Hydraulic cylinder 172 in tension dampens the return motion of spring 165. This damping helps prevent snapback of the foot board assembly 54, which might otherwise present safety hazards.

The cushion 33 not only enhances patient comfort but can also cushion engagement of foot board 54 with the floor, as the patient exits or enters bed 29. Additionally, in case a care giver is unalert and places a foot beneath foot board assembly 54, and a patients weight does cause foot board assembly 54 to contact the caregiver's foot, heavy padding of cushion 163 distributes the weight and cushions the foot to help prevent excessive discomfort to the caregiver.

Pins 190 and 191 held in position beneath foot board assembly 54 by nuts 192 and 193 may be placed in a release position so as to allow foot plate 162 to articulate about secondary attachment hinge 189. Said release allows patient support foot cushion 33 to lie coplanar with leg cushion 32. This may be desirable when the bed surface is in a horizontal position if the caregiver wishes to minimize pressure against the patients feet.

As is best shown by FIG. 8, the left side rail generally comprises metal frame 144 encased by molded plastic covers 145 and 146. Frame 144 is generally dependently attached to side rail

mounting plate 149 through weldments 59 and 60 and shafts 147 and 148. Weldments 59 and 60 and shafts 147 and 148 are themselves major components of a mechanism 56 for raising and lowering of side rail assembly 41. Said mechanism 56 is also utilized for lateral translation of side rail assembly 41 thereby extending or compressing the lateral dimension of treatment bed 29. Details of the manufacture and use of mechanism 56 will be evident further herein.

Referring still to FIG. 8, molded plastic covers 145 and 146 serve not only to provide aesthetically pleasing appearance, but provide mounting for a side rail micro-controller unit 156, scale function membrane switch 157, and bed function membrane switch 158. Additionally, covers 145 and 146 provide mounting for a liquid crystal display (LCD) 160 and receptacle 159 used to provide optionally connectivity for a hand held bed function control pendant 45. Pendant 45 is shown in FIG. 10 and detailed further herein.

Scale function membrane switch 157 allows a caregiver to effect scale operations such as ZERO, HOLD, WEIGH DELAY, SET and EXIT ALARM. Liquid crystal display 160 is necessary for visual feedback to the care giver in effecting scale operations as such effect takes place through a system of menus. The details of all scale operations will be evident further herein. Bed function membrane switch 158 allows a caregiver to effect operations of BED UP, BED DOWN, HEAD UP, HEAD DOWN, LEGS UP, LEGS DOWN, TRENDLENBURG and REVERSE TRENDLENBURG as previously described. Side rail micro-controller unit 156 processes input from scale function membrane switch 157 and bed function membrane switch 158 and generates display information for LCD 160. Data communication from the switches 157 and 158 and the other control components in siderail 144 are conveyed to the master controller via line 60', which passes through a central tunnel in member 60 and shaft 148. As will be evident further herein, micro-controller unit 156 serves as a slave in the serial communications architecture of the preferred embodiment. This architecture is shown in FIG. 12.

The scale function ZERO allows the weight of the bed to be set to zero prior to patient placement thereby compensating for linens and accessories. Scale function HOLD retains the current weight in memory while additional items, such as traction equipment, are added thereby eliminating inaccuracies as would otherwise be introduced by such activity. The scale function WEIGH DELAY postpones weighing for a specified time while tubes, drainage bags and the like are lifted thereby giving accurate reflection of the patient's weight only. Scale function SET is used to enter a previously known weight of the patient. Scale function EXIT ALARM detects weight decreases of ten percent or more and in such case sounds an audible alarm.

Referring back to FIG. 2, wherein both left side rail 41 and right side rail 40 are depicted, dependent attachment of left side rail 41 is shown to comprise not only mounting plate 149, weldments 59 and 60 and shafts 147 and 148, but also mechanism 56. As is apparent by depiction of weldments 57 and 58 and mechanism 55 for right side rail 40, all components and functions of left side rail 41 are mirrored in right side rail 40. Referring again to FIG. 8, mechanism 56 comprises those elements necessary for raising, lowering or laterally translating left side rail 41. Weldments 59 and 60 are dependently cantilevered from shafts 147 and 148 in fixed position. Shafts 147 and 148 freely rotate and slide laterally within bushings 149 and 150. Bushings 149 and 150 are dependently attached to mounting plate 149 in fixed position. Pawls 152 and 153 are connected by rod 154 in such manner as to require coordinated motion of said pawls. A plurality of rectangular pegs form teeth on shafts 147 and 148 in such a manner as to form a ratchet mechanism with pawls 152 and 153. In the preferred embodiment, the said ratchet mechanism allows side rail 41 to be raised by lifting only from a lowest TRANSPORT position to either a middle LOWERED position or the upper RAISED position. In order to lower side rail 41 from the RAISED position to the LOWERED position or from the LOWERED position to the TRANSPORT position, lever 155 must be manually articulated in order to cause release of pawls 152 and 153 from the teeth of shafts 147

and 148. From the LOWERED position, side rail 41 may be freely translated laterally outward from the center of bed 29. This configuration is referred to as EXTENDED in the preferred embodiment. From the EXTENDED position, side rail 41 may be returned to the RAISED position. Side rail 41 which is in EXTENDED RAISED position must be lowered prior to translation back toward the center of bed 29, the NORMAL position. In the TRANSPORT position, side rail 41 of the preferred embodiment may be further translated toward the center of bed 29 beneath seat assembly 52 thereby reducing the overall lateral dimension of bed 29 sufficiently so as to be able to fit said bed through a standard hospital doorway. Although the excessive width of bariatric patient treatment beds has long been recognized as an undesirable characteristic for transport, prior art embodiments of bariatric patient treatment beds have failed to provide an economical, reliable and easy-to-manufacture side rail design with multiple functions and *abilities* for use on a bariatric bed such as bed 29.

As is well known in the art of design and manufacture of treatment beds for bariatric patients, the bariatric patient is often of such limited mobility as to make it impracticable for said patient to utilize bed function controls mounted on a side rail. Referring now to FIG. 10, there is best shown a hand held bed function control pendant 45. Pendant 45 comprises molded plastic body 198 encompassing necessary electronic hardware as is common in the industry and clip 201 held by gasket 202. Clip 201 allows the patient to attach pendant 45 to clothing or other articles increasing accessibility to pendant 45. Pendant 45 includes a plurality of push button switches 203-210 allowing the patient to control such functions as BED UP, BED DOWN, HEAD UP, HEAD DOWN, LEGS UP and LEGS DOWN as have been previously detailed. Pendant 45 attaches to either the left or right side rail 40 or 41 by cord 199 and plug 200. As will be apparent further herein, the serial communications architecture of bed 29 is interrupt driven. This architecture allows pendant 45 to be inserted in parallel with side rail controls 158 without need for further configuration.

Referring to FIG. 11, the power distribution and control structure for the preferred

embodiment is shown. Each side rail 40 and 41 comprises a "Intel" 8031 type micro-controller 156 and 215, a plurality of membrane switches 156, 158, 212 and 214, LCDs 160 and 216 and pendants 45 and 213. Additionally each side rail 40 and 41 comprises attachment points 211 and 217 for parallel electrical connection of pendants 45 and 213 with membrane switches 158 and 212. Within the junction box assembly 104 of bed 29 there is a "Intel" 8031 type micro-controller scale interface unit 222, a "Intel" 8031 type micro-controller solid state relay master micro-controller 220 and power interface unit 221 which serves to carry out bed function control inputs. The "Intel" 8031 type micro-controller of the solid state relay integrated circuit board 220 operates as a serial communication master controller. Board 220 communicates to slave controllers, namely to each of the "Intel" 8031 type micro-controllers 156 and 215 embedded within each side rail 40 and 41, as well as a third "Intel" 8031 type micro-controller on the scale interface unit integrated circuit board 222. The transformer assembly 103 comprises transformer 247 and main power switch 219 as well as standard power cord 218. Optional limit switches 223 may be placed on the bed as desired for safety purposes and interfaced to solid state relay board 220.

As is best shown by the flow diagram of FIG. 12, subsequent to the completion of the power-on initialization sequence of bed 29 for each of its electronic assemblies, the solid state relay board micro-controller initiates 225 a one hundred millisecond serial communications sequence 224 in a 25 millisecond timed interrupt driven process. Once every 25 ms the solid state relay board micro-controller communicates with one of its three slaves. The serial communications sequence 224 operates as a continuous loop and at the conclusion 242 of each 100 ms cycle the sequence starts again at step 225.

During the first 25 ms stage designated as step 226 of the serial communication sequence 224 data denoting left side articulation commands, left side alarm weight, left side zero weight, left side activation status, and left side exit alarm activation status is read from the RAM of the left side

micro-controller unit **156** and written to the RAM of the solid state relay board **220**. During the second 25 ms interrupt stage designated as step **227** of the serial communications sequence **224**, data denoting right side bed articulation commands, right side alarm weight, right side zero weight, right side activation status, and right side exit alarm activation status is read from the RAM of the right side micro-controller unit **215** and written to the RAM of the solid state relay board **220**. In step **228**, at the beginning of the third 25 ms interrupt stage of serial communication sequence **224** the solid state relay board micro-controller unit **220** determines if the right side micro-controller unit **215** has been activated for scale functions during the present 100 ms cycle, one cycle being defined as consisting of those elements shown in FIG. 12. If in step **228** it is found that the right side micro-controller unit **215** has been activated for scale functions within the present cycle, the remaining time in the third 25 ms interrupt stage is utilized by step **229** of serial communications sequence **224** to replace display of scale information on the left side rail LCD **160** with a message stating that the left side is inactive for scale functions. If in step **228** of serial communications sequence **224** it is determined that the right side micro-controller unit **215** has not been activated for scale functions within the present cycle, the solid state relay board micro-controller unit **220** then determines during step **230** of the sequence **224** if either the right side alarm weight or the right side zero weight values ascertained in step **227** of sequence **224** represent a change from the values ascertained during the 100 ms cycle immediately previous to the present 100 ms cycle. If change is indicated in step **230** of serial communications sequence **224**, the newly ascertained right side values are read from the RAM from the solid state relay board micro-controller **220** and written to the RAM of the left side micro-controller unit **156** in step **231** during the time remaining in the third 25 ms interrupt stage. If no change is indicated in step **230**, serial communications sequence **224** continues in step **232** with a determination of the left side rail micro-controller unit **156** active/inactive status. If in step **232** of serial communication sequence **224**, the left side

micro-controller unit **156** is found to be active for scale functions the remaining time in the third 25 ms interrupt stage is utilized in step **233** to read raw weight data from the RAM of the solid state relay board micro-controller unit **220** and write the retrieved data to the RAM of the left side micro-controller unit **156**. If in step **232** of serial communication sequence **224** the left side micro-controller unit **156** is found to be inactive for scale functions, the remaining time in third 25 ms interrupt stage is utilized in step **234** of sequence **224** to read raw weight data from the RAM of the scale interface unit **222** and write the retrieved data to the RAM of the solid state relay board **220**.

The fourth 25 ms interrupt stage of serial communications sequence **224** commences in step **235** with the determination of whether the left side rail micro-controller unit **156** has been activated for scale functions within the present 100 ms cycle. If in step **235** of serial communication sequence of **224** it is determined that the left side rail micro-controller unit **156** has been activated for scale functions within the present cycle, the time remaining in the fourth 25 ms interrupt stage is utilized in step **236** to replace display of scale information on the right side rail LCD **216** by a message stating that the right side is inactive for scale functions. If in step **235** it is determined that the left side rail micro-controller unit **156** has not been recently activated for scale functions, communications sequence **224** continues in step **237** with determination of whether either the left side alarm weight or left side zero weight values ascertained in step **226** of sequence **224** represents change from the values ascertained during the 100 ms cycle immediately previous to the present 100 ms cycle.

If change is indicated in step **237** of serial communications sequence **224**, the newly ascertained left side values are read from the RAM of the solid state relay board **220** and written to the RAM of the right side micro-controller unit **215** in step **238** during the time remaining in the fourth 25 ms interrupt stage. If no change is indicated in step **237**, serial communications sequence **224** continues in step **239** with determination of whether the right side rail micro-controller unit **215** is active or

inactive for scale functions. If during step 239 of serial communications sequence 224 it is determined the right side micro-controller unit 215 is active for scale functions the sequence 224 continues in step 156 by utilizing the remaining time of the fourth 25 ms interrupt stage to read raw weight data from the RAM of the solid state relay board micro-controller unit 220 and write the retrieved data to the RAM of right side micro-controller unit 215. If in step of 239 of sequence 224 it is determined that the right side micro-controller unit 215 is not active for scale functions, the time remaining in the fourth 25 ms interrupt stage is utilized in step 241 of sequence 224 to read raw weight data from the RAM of the scale interface unit 220 and write the retrieved data to the RAM of the solid state relay board micro-controller unit 220. The sequence then repeats 242 commencing at step 225.

It is also notable that the foregoing description primarily describes an embodiment that is substantially the same as a product which is commercially available under the designation "BariKare" Bed. This bed, which is in essence bed 29, has an overall length of 87.5 inches, a height variable between 21.25 to 27.5" from the floor to the hard pan surface of the seat section, a mattress 11 measuring 80"L by 36"W by 5" thick, a caster diameter of 5", siderail height of 21.5", siderail length of 48", and overall bed weight of roughly 665 pounds. The width of such bed varies depending on which position the siderails are in -- 40.25" with the siderails in the transport position, 43.25" with the siderails in the normal position, and 54" with the siderails in the extended position. The same dimensions are applicable to the above-described bed 29. As of filing of this application, such "BariKare" Bed is available through Kinetic Concepts, Inc. of San Antonio, Texas. Accordingly, reference to such commercially available bed and/or its accompanying descriptive information may provide even further understanding of the finer points of the preferred embodiments.

Although the present inventions have been described in terms of the forgoing embodiments, this description has been provided by way of example only and is not to be construed as a limitation

on the invention, the scope of which is only limited by the following claims. Those skilled in the art will recognize that many variations, alternations, modifications, substitutions and the like are ready possible to the above-described embodiments. Only a partial sampling of such variations have been pointed out herein.

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